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THE NEW ENGLAND BOTANICAL CLUB

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NATURAL HYBRIDS IN SPIRANTHES AND HABENARIA.

OAKES AMES.

(Plate 47.)

AN interesting natural hybrid derived from *Spiranthes gracilis*, Bigelow, and *S. praecox*, Watson, was detected recently in Easton, Massachusetts, growing in close proximity to the parent species in an open dry field. A single specimen, together with several specimens of *S. praecox*, was collected on September 3, 1903, by A. A. Eaton, who, though he suspected the origin of the odd specimen, sent it without comment to the writer. So it happened that independently of each other two people arrived at similar conclusions. A second and third trip to the same locality brought to light a dozen specimens, all quite intermediate in character and distinctly hybrid. The resemblance between these hybrids and one parent or the other would readily mislead a collector whose interests were not specially concerned with this particular group of orchids, and it would not be strange if such hybrids have been grouped arbitrarily with *Spiranthes praecox* or *S. gracilis*. To obtain the relatively few plants, which have been studied for the preparation of this note, a large area was searched and the material collected carefully examined.

The *Spiranthes gracilis* which should be regarded as a parent of the hybrids in question is the typical New England form, which blooms in late summer and early autumn. Likewise the *S. praecox*, with which we are concerned, is the New England form which usually completes its season of bloom by the end of the second week in September. These remarks may seem quite commonplace, but they are

made because of the seasonal differences in anthesis in several of the Spiranthes species in their northern and southern habitats, and because of segregates from *S. praecox*, which have been described recently.

Although the range of variation in most of our Spiranthes is astonishingly extensive, it would be difficult to account for the peculiarities of the Easton plants on any supposition other than hybridity. Some among these were much like *S. gracilis*, but the leaves, the pubescence, and the narrow hyaline margins of the floral bracts were decidedly similar to *S. praecox*. Of the plants resembling *S. praecox* in their inflorescence the broad, elliptic-lanceolate leaves and the green callosities near the base of the oblong lip were conclusive evidence of an unusual origin and constitution.

The leaves of the hybrids varied in form and in dimensions; they rarely attained the average length of *S. praecox* leaves, and were not as short as those of *S. gracilis*. However, they proved to be intermediate in varying degrees.

The pubescence of the scape, rhachis and capsules was distributed much in the same way as in *S. praecox*, but was decidedly shorter, less dense, and in some forms quite obscure. In fact the tendency toward glabrity in one parent and the tendency toward pubescence in the other produced a mean in the hybrids, an interesting consideration when contrasted with the dominant and recessive characters peculiar to Mendelian race-hybrids.

Several specimens with a distinctively *S. gracilis* aspect produced flowers which never expanded, and in one specimen which resembled *S. praecox* the same tendency, though less marked, was noted.

The flowers were variable in length, but for the most part intermediate in this respect. They were not so white as in *S. gracilis* nor so yellow as in the typical *S. praecox* of the region where the hybrids were found. The coloring of the lip was distinctive; yellow-green at the apical, greenish near the proximal end; the callosities or nipples were green at their base with a whitish apex. As far as observed the color of the callosities was decisive in the determination of the hybrids.

SPIRANTHES × **intermedia**, hyb. nov. Plants 27–42 cm. tall, slender; tubers about 7 cm. long, 6 mm. thick near the base; leaves lance-linear or elliptic-lanceolate, 4.5–8.5 cm. long, 8–15 mm. wide, passing into slender petioles; cauline bracts lance-linear, pointed; scape pubescent above, pubescence short, rather dense or sometimes

obscure; rhachis 6–16 cm. long; floral bracts ovate-lanceolate, abruptly acuminate, longer than the ovaries, with a faint hyaline margin; flowers 6–7 mm. long, in a spiral or one-sided spicate raceme; lateral sepals deflexed, lanceolate, margins involute, upper sepal oblong, obtuse, all the sepals sparsely pubescent; petals oblong, obtuse, tapering slightly to the base, equalling in length the upper sepal, and connivent with it; lip oblong, somewhat flaring at the strongly deflexed apex, green, or yellowish toward the proximal end, with a broad, whitish, erose margin; callosities green with a whitish or yellowish apex, partially pubescent. In dry upland fields, Easton, Bristol County, Massachusetts, Sept. 3, 8, 10, 1903. (*A. A. Eaton*).

Spiranthes × *intermedia* is a non-Mendelian hybrid. It is intermediate throughout, the characters of both parents being merged in all the important vegetative and floral parts. The capsules produce good seeds with plump embryos, and there is no reason to infer that the pollen has been impaired in efficacy through the influences of hybridization. The probabilities are, if horticultural experience with orchids is to count, that *S.* × *intermedia* can reproduce itself from seeds provided pollination and subsequent fertilization are effected by kindred pollen; and that the plants will act as species in their development. In fact, if seeds should germinate in a locality far enough removed from the parent species to make future pollination from them an exception rather than the rule, it would be rational to suppose that the hybrids would develop rapidly into a localized species. The plants increase by means of offshoots, and even when mingled with *S. praecox* and *S. gracilis* would survive long enough to ensure, through the laws of chance, an occasional successful cross with another hybrid, — a process which would tend to increase their number and so render more likely their perpetuation by seed.

The scattered occurrence of the hybrids forms the basis for the belief that more than one cross has been effected in the region of Easton. Furthermore, it is interesting to note that secondary hybrids may be represented by several ambiguous forms of *S. praecox* concerning which it has been thought best to withhold an opinion at this time.

In Rhodora (iii. 245) Mr. A. LeRoy Andrews described an odd form of Habenaria as a natural hybrid from *H. psycodes* and *H. lacera*. His specimens were collected in a wet meadow in Pownal, Vermont, on July 22, 1898, and on August 5, 1901. Mr.

Andrews sent to the writer a single specimen, which was collected on Aug. 5, 1902. This had more the appearance of *H. lacera* than of *H. psycodes*, but showed unmistakable evidences of hybrid origin. About a year ago, among specimens from the herbarium of Mr. John A. Wheeler, the writer found a single example of this hybrid, provisionally determined as *H. psycodes*, which Miss L. O. Eaton collected in South Chesterville, Maine. The flowers were quite intermediate in character, the petals and the deeply lacerate lip being indicative of the influences contributed by *H. lacera*. The plant has no date of collection, but it is interesting to note the fact that *H. psycodes* × *lacera* has been found in Maine.

Natural hybrids do not seem to be common among New England orchids, but intensive study may bring more to light. Often the characters which designate hybridity are extremely elusive, and hybrids are classed arbitrarily with the species to which they bear the closest resemblance. As a general rule orchids which hybridize freely give rise to progeny of an intermediate character, but when specific lines are closely drawn, and based on traits phylogenetically young, parental differences may not stand out with sufficient distinctness to attract special attention and so hybrids may well be overlooked.

How far the principles laid down by Gregor Mendel apply to *Orchidaceae* can not be stated with surety, but among the generally cultivated exotic species non-Mendelian hybrids seem to prevail. However, among such variable species as *Habenaria hyperborea*, from which questionable segregations have been made it may be probable that race-hybrids play an important part. Many of the *H. hyperborea* segegates are based on very slight variations in the vegetative and floral organs, on the relative proportions of the lip and spur, and on differences which can not be regarded as constant enough for critical determination. That these characters are of slight varietal value and perhaps merely racial, may explain away some of Dr. P. A. Rydberg's recently described species as simple Mendelian race-hybrids and their derivatives, which illustrate the remarkable peculiarities of recession and dominance and the redistribution of traits.

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Explanation of Plate 47.—Two forms of *Spiranthes* × *intermedia*, hyb. nov. Fig. 1, lip of *S. gracilis*, Big. (× 3); Fig. 2, of *S.* × *intermedia* (× 3); Fig. 3, of *S. praecox*, Wats. (× 3.)

REVERSIONARY STAGES EXPERIMENTALLY INDUCED IN DROSERA INTERMEDIA.

R. G. Leavitt.

The existing species of *Drosera*, more than 90 in number, without doubt have descended from a common original stock bearing leaves provided with tentacles like the tentacles found throughout the genus to-day. What the form, or outline, of the primitive Droseraceous leaf was, is a question which it is important to answer in considering the meaning of certain stages of development which make their appearance, under given conditions, in several species which I have had under observation. In the absence of actual relics of the very ancestors themselves, we must infer the original condition from a comparison of the living species, from the facts of their geographical distribution, and especially from their comparative ontogeny. If the results developed from these several kinds of data agree, we may have a good deal of confidence that our inferences are rightly drawn. The evidence can be given only in outline in this brief paper. The conclusion may be stated at the outset: the original type of leaf was probably not unlike that of our *Drosera rotundifolia*.

When we compare the Sundews of the world we find that, as to leaf-form, they fall into a few classes, with seemingly intelligible interrelationships. The transitions between the salient groups are marked by intergrading species. There is, first, the group with strictly linear, filiform leaves (*e. g. Drosera filiformis*), embracing eight species. The still fewer species with much elongated, narrow, spatulate leaves bridge the gap between the linear and the rounded. The roundish-leaved species number about 56; that is, species whose leaves approach the orbicular form found in *Drosera rotundifolia* much more than they do either that characteristic of *D. filiformis*, or that of *D. binata*. The next group, comprising about 15 typically Australian species, has the leaf-blades not elongated nor much broadened, crescent shaped or orbicular, and peltately attached. The affinities of this type are not clear, except from a study of the ontogenetic development; from this source, however the indications are unequivocal. Some members of the peltate group would afford a fairly satisfactory passage from the rounded type to the extremely

broad one appearing in *Drosera binata*. This remarkable Australian species has leaves which sometimes attain a height of more than two feet. The blades are described as "2-forked," or "divided to the base into two long linear lobes." In reality the blade is entire, and is extraordinarily broadened, so that it extends transversely to the main axis of the leaf into two linear arms. These arms are turned upward and give the two-forked appearance. Of the same type is the little New Zealand *Drosera flagellifera*.

The above enumeration omits a few ambiguous — or for present purposes negligible — species. However, it fairly represents the genus, and will serve to illustrate the distribution of leaf-forms amongst the species.

The prominent types arrange themselves naturally in a series, beginning with the filiform, thence passing, by means of the elongated spatulate, to the rounded; then, by the accentuation of breadth, advancing through or near the crescent-shaped to the so-called two-forked. The series might represent a single line of evolution, with the point of origin at one end or the other; or the series may comprise two lines of development, having a common starting point in the round leaved group. Considering the course to have been a simple one, it is conceivable that the extremely broad may represent the primitive condition. But this supposition is improbable, upon the face of it, because the given form is so unusual in plants; it is in fact unique. The *D. binata* type seems to be terminal rather than original. Or *Drosera filiformis*, at the other end of the line, may stand for the archetype. Three of the genera of *Droseraceae* have leaves of nearly the same description as those of *D. filiformis*, except as to the structure of the glandular hairs. The number of linear-leaved species of *Drosera*, however, is small; and furthermore, on grounds which cannot here be stated, two of these should be excluded from consideration in this connection. We have left six species which may be modern representatives of an original *Drosera* stock. But the filiform condition as seen in *Drosera filiformis* again, is unusual in plants and looks rather like the product of special evolution than like a stock-form. It might readily have been derived from the rotund by steps which to-day are preserved in *Drosera longifolia* and *linearis*.

The rounded style — under which I include the forms like or approaching that which obtains in *Drosera rotundifolia* — is clearly

related to that which characterizes the leaf in the two remaining genera of *Droseraceae*, namely *Dionaea* and *Aldrovanda*. It is not an unusual, extreme, or highly specialized figure among leaf-forms in general. It prevails overwhelmingly in the genus *Drosera*. From it all the types in the genus are derivable. From a study of the specific forms and their distribution within the genus, accordingly, it seems easiest to regard the roundish leaf as primitive.

The facts of geographical distribution point in the same direction. The *D. rotundifolia* type, with the more broadly spatulate leaves, is cosmopolitan and is most widely distributed, whether we consider the whole group or individual species. *Drosera rotundifolia*, for example, encircles the globe in the northern hemisphere, and in latitude ranges from within the arctic circle to the southern United States. *Drosera intermedia* is hardly less widely spread. Other types, on the contrary, are in comparison much restricted geographically. Thus the peltate-leaved group is practically confined to Australia and vicinity, though one member has found its way across the islands to India. Similarly *Drosera filiformis* is confined to the Atlantic border of the United States from Massachusetts to Mississippi. An extension for the general type, however, is found within apparently somewhat narrow limits in Brazil. Generally speaking those forms which have the appearance of being the most specialized and least likely to represent the ancestral stock are geographically most restricted. In so far as any conclusion at all may be arrived at from this kind of evidence, it is that the fundamental form amongst the Sundews is that of the round-leaved, or roundish-leaved, kinds, and that the other forms have been derived from it.

While the foregoing considerations, which necessarily lose some of their force from being much condensed, may not of themselves furnish a sure argument, they materially substantiate inferences drawn from a comparison of individual, or ontogenetic, development in several diverse species.

As is well known, organic beings often have a marked qualitative as well as quantitative development after birth or germination. At the beginning of its independent career, oftentimes the plant manifests properties which it subsequently adds to or diminishes or entirely loses. In infancy qualities appear which seem to be natural to infancy alone. These are later replaced by characters proper to approaching maturity. Finally the adult characteristics make their

appearance, while the earlier phases vanish wholly. Such a qualitative development of the individual has been shown to be in many cases essentially a recapitulation of the historical evolution of the species or family or larger group to which the individual belongs. And in a general way it may be said that the generations of animals and plants perpetually repeat the stories of their several races.

Yet it is not safe to judge that whenever the infantile condition of a plant differs from the adult state, the former is due to reversion. In each instance regard must be had for inherent or adducible probability. To illustrate, and at the same time to come directly to the case in hand: when we find that seedlings of *Drosera intermedia* begin with rotund leaves and bear only round-bladed leaves until they are considerably advanced in age, we may suspect that the youthful leaf reproduces an ancestral type. For evidence which may throw more light upon the problem we should, however, study ontogenesis in other species. As a matter of fact we do find that several species which in the adult state differ widely in the leaf agree at an earlier period and bear rotund leaves like the infantile leaves of *D. intermedia*. From all the cases of ontogenetic progress which I have been able to observe, with one merely negative exception, the indications are the same, and point to the existence of a fundamental type such as that which *Drosera intermedia* realizes in its earliest phases, from which the several species considered have probably arisen.

Concordant ontogenetic evidence certainly has great value. Upon this principle and facts which cannot here be presented, the two-forked type embodied in *Drosera binata* and *flagellifera*, and the peltate type seen in *Drosera lunata* and fourteen related species, become derivatives from a rotund original. The African *Drosera cistiflora*, in its highest state characterized by long narrow lanceolate or linear-lanceolate leaves, and several closely allied species, may be traced back to a spatulate source; as may also *D. filiformis*. And the spatulate form in turn reverts to a rotund original.

I have now outlined the reasoning by which I am persuaded that the small leaves with orbicular blades bearing marginal tentacles of a curious structure to be described below, which seedling plants and small adventitious plants of *Drosera intermedia* put forth, are reversionary. Being satisfied as to their nature, I have made a number of experiments with a view to determine some of the conditions of

reversion. I have sought to make mature plants repeat the youthful, ancestral stages, and have succeeded by disturbing the nutrition. When these adult plants are starved for a time they begin to manifest the desired atavistic traits. Moreover, these traits are not altogether due to simplification. In the tentacles of reversionary leaves borne by the weakened plants I find an added complexity in a particular respect — a fact of great significance to the general theory of reversion.

I took as subjects of experiment, plants of several species of *Drosera*. I cut off the roots, the leaves, and all but a little of the stem, leaving a quarter of an inch of the summit, with the growing bud. I placed them in wet sphagnum in an upright position and under conditions favorable to growth. They continued to put out leaves, which I took off and examined about as fast as they were produced, and of which I kept a record. I shall use *D. intermedia* to illustrate the result.

Some of the plants of *D. intermedia* used had, before the experiments began, the full character leaf. Others, while full grown, were still putting out round bladed leaves. All were producing tentacles of the ordinary type. After being treated as above described the former bore at first leaves reduced in size but still spatulate. But after a few of these leaves had been taken off, and the leaves formed in the bud subsequent to the beginning of the experiment — as we may believe — had begun to appear, they were all found to be orbicular bladed. Those plants which began with round blades continued to bear them; while uninjured control plants growing beside them developed the normal adult leaf with spatulate blade. The experiment was continued throughout the summer with uniform result.

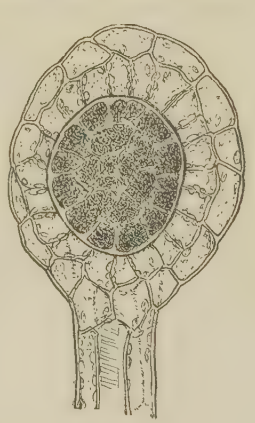

Fig. 1. Reversionary marginal tentacle of Drosera intermedia (magnified.)

When full maturity is reached, the tentacles of *Drosera intermedia* are all essentially of one sort. The oval purplish gland, which secretes the viscid fluid for catching insects as well as the digestive juices that are poured upon captured prey, is terminal upon the stalk. The axes of gland and stalk coincide.

This style of tentacle prevails throughout the genus. On the youthful leaves of all the species which I have been able to see in their early stages there are, however, two kinds of tentacles. Those on the margin of the leaf are more complex in this respect, that the gland is borne laterally upon the expanded extremity of the tentacle (Fig. 1). The axis of the gland is at right angles to that of the stalk.

The flattened, round, ovate, or elliptical extremity, serving as a support for the nearly hemispherical gland, extends on all sides beyond the base of the latter. Tentacles possessing such a structure are found on young individuals of, not only *Drosera intermedia*, but also *D. rotundifolia*, *capillaris*, and *binata*, and sometimes on *filiformis*. In the first three species named they persist nearly or quite to the maturity of the plant, but under a much changed aspect. In *Drosera intermedia* they disappear when the leaves become spatulate, if not before. In *Drosera rotundifolia* they may or may not be present in the modified form throughout life, while in *Drosera capillaris*, according to my material, they disappear. In several of the exotic orbicular-leaved species they are found in the adult, as I discover from herbarium specimens. In *Drosera binata* they begin to disappear as soon as the leaves depart from the primitive orbicular pattern, and are not found even in a modified form in the adult. They must be regarded as reversionary when they appear on leaves of primitive type in the species destitute of such tentacles at maturity, and also when they appear in those species which at maturity possess them only in a modified form. In *Drosera intermedia* they seem to me clearly to be products of reversion, and to constitute valuable indices for the study of the laws of reversion.

My experimental plants bore them seemingly as the direct result of the weakening to which I subjected them. The mode of their appearance was interesting. They appeared first at the tip of the leaf. Perhaps the first leaf to manifest the reversion would have but one tentacle of the flat-headed style, and in that case the very end tentacle would be the aberrant one. The next leaf would have perhaps three or four, at the end, affected. The atavistic tendency would then pass down the margin toward the base in succeeding leaves, until all the marginal tentacles had become reversionary, except one or two next to the petiole.

The effect recorded, namely the reappearance of ancestral traits

involving increased complexity of certain organs, was obtained when the supply of nourishment to the growing points where these organs were in process of formation was curtailed. Reversion seemed to be caused by disturbance of the nutrition.

Observations which I have made on the peculiarities of adventive growths of *Drosera binata* support the same conclusion. I have noted that when adventitious buds are formed on the flower scapes or on the roots — parts relatively large and affording abundant nourishment, especially in the case of the roots, which are stout and full of starch — the leaves produced are generally from the first of the *D. binata* type; that is, not reversionary. But if the plants are small and appear poorly nourished they are reversionary in leaf form and marginal tentacles. Buds arising from the leaves, relatively slender parts poor in nutritives, give small plants which bring forth rounded leaves for a time; that is, they revert.

In Rhodora, ii. 149, I published notes on reversion of *Berberis* leaves. The behavior of *Berberis* is like that of the *Drosera intermedia* of my experiments, in that a limited food supply (in the seedling) or decreased vigor (in autumnal leaves) is associated with reversion to a higher structural condition. The petiole is reduced to a mere rudiment in the full character leaf. The seedling leaf and oftentimes the last leaves of the season on fully matured bushes have not only blades entirely different from the ordinary blade, but in addition well developed petioles.

When, as in the petiole of *Berberis* and the tentacle of *Drosera intermedia*, the structure becomes more complex, we may speak of the reversion as ascending. Return to a simplified state may be termed descending reversion. The anatomical structure of the *gland* of the flat-headed reversionary tentacles in *Drosera* is simpler than that of the characteristic gland of the genus. In certain respects, therefore, the case of the *Drosera intermedia* upon which I have experimented is one of descending reversion. In other respects the reversion is ascending. Both sorts of reversion appear in this example to be occasioned by the same condition, namely limitation of the materials of construction.

The occurrence of reversionary leaves of simplified type on suckers springing from the bases of tree trunks is well known. Here reversion would seem to be due to — it is certainly correlated with — an increased stock of formative materials; for such suckers com-

monly are exceptionally vigorous. An interesting instance of return to an ancestral character of higher grade is described and illustrated by Dr. E. C. Jeffrey in his account of the resin ducts of *Sequoia*. The primitive structure reappeared where the food supply had been increased and growth had been stimulated as the result of a wound.

The foregoing facts are representative of a considerable body of data [1] which might be brought forward in support of certain general statements to which I may give the following form: (1) Reversions, in either an ascending or a descending direction, are sometimes occasioned in plants by a deficiency of the food materials supplied to developing parts; and (2) Reversions, in either direction, are sometimes occasioned by a superabundant food-supply in developing parts.

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ASPLENIUM EBENEUM PROLIFERUM.

C. E. Waters.

The most familiar instance of a fern with proliferous fronds is the walking-fern (*Camptosorus*). The greatly prolonged tip of the frond is pushed into the moss on the surface of the rock, and a young plant is developed. At first the tip thickens, then rootlets start out, and finally the small fronds appear. A tropical species (*Polystichum Plaschnickianum*) has almost the same outline of frond, and the same method of reproduction as the walking-fern. Scott's spleenwort (*Asplenium ebenoides*), which has now been definitely shown to be a cross between *Aspl. ebeneum* and *Camptosorus*, is occasionally seen with young plants at the tip of the frond, or even of the pinnae, a trait which has evidently been inherited from the walking fern. It is also said that the closely related *Aspl. pinnatifidum* is at times proliferous.

None of our other ferns has this trait, unless we except the bulbs

[1] Dr. R. T. Jackson, in a memoir too little known to botanists, has described a large number of instances of localized reversionary stages in plants and animals. This contribution to the subject of reversion is an extremely important one. Dr. Jackson recognizes the dependence of reversionary forms upon conditions of nutrition and growth. Memoirs Boston Society of Natural History, vol. 5, no. 4, 1899.

of *Cystopteris bulbifera*, which appear to be a special case of proliferation in which the young plants drop off at an early stage, instead of receiving sustenance from the parent until fully established. They differ also in being formed on the rachis and midribs, instead of only at the tips of the fronds or pinnae.

While cleaning the roots of a specimen of *Aspl. ebeneum*, I noticed what seemed to be a queerly shaped pinna on an otherwise bare stalk. It was soon seen that a small plant had sprung from the stalk. It was on the rachis of a sterile frond of the previous year, which had been covered with earth, and was at the point of attachment of the lowest pinna. The root was broken, but the part that remained was 8 mm. long. The first leaf, shaped somewhat like a small basal pinna, was 3.5 mm. in length. The second frond, nearly 4 mm. long including the stipe, had three lobes, the middle one being much the largest and three-notched at the end. One of the lateral lobes was slightly notched. The young plant did not seem to be in the axil of the old pinna, but exactly at the point of attachment.

I have been informed by Mr. B. D. Gilbert that this form was described about thirty years ago by Professor D. C. Eaton, who called it *Aspl. ebeneum proliferum*. It calls to mind the tropical ferns that bear buds and young plants on the upper side of the rachis, but these are produced normally, and not when the stalk is covered with earth. It may be that this is the determining cause in the case of our specimen, for it was normal in other respects. At the same time it must be admitted that this is not the only reason, for a careful search did not bring to light any more like it on other buried stalks.

It would be well worth while for some one to see whether this condition could be brought about experimentally. One might try, for instance, the effect of covering the rachis with earth at different seasons, and cover not only the perfect fronds but those that have part or all of the pinnae removed. The plant in question was growing in rather moist soil on the steep bank of a little stream.

Johns Hopkins University.

ADDITIONAL NOTES ON BOTRYCHIUM TENEBROSUM.

A. A. Eaton.

(Plate 48.)

During the past season I have made a few additional observations on *Botrychium tenebrosum*, A. A. Eaton, and in making them public it seems advisable to incorporate them in a general description for the readers of Rhodora, so that they may familiarize themselves with this quite common but little known New England plant.

Botrychium tenebrosum (Plate 48) is a species found only in rich humus or leaf-mould, in deep moist shade. It is usually quite small, often thread-like, and fruiting even when covered by leaves, but sometimes growing to a height of 9 inches. Usually the plants are 3 to 4 inches high. They are yellowish green, very glabrous and shining when young, decumbent and stramineous when older, becoming thin and transparent when pressed. The sterile laminae are near the fertile, often overtopping them (Fig. 3). They are always simple with 2 to 8 distant, lunate, rarely incised lobes, the terminal usually retuse (Figs. 8, 9). The lobes are apparently never spread out flat, but are in the same position which they have in bud. The fertile lamina is usually simple, the large sporangia being sunk in the tissues of the broadened rachis. When the frond is compound, the ultimate segments are similar to the fruited segments of the sterile lamina, the rachis broad and leaf-like (Fig. 5).

It is apparently a northern species, being quite rare about North Easton and Brockton, Massachusetts, the southernmost point from which I have it. In southern New Hampshire and northern Massachusetts it usually is found in wet maple swamps, often in or around the depressions near sluggish streams in which leaves accumulate and decay. My first plants were growing in sphagnum. The sparse vegetation is often of *Onoclea sensibilis* and *Rhus Toxicodendron*, and it is often accompanied by *B. matricariaefolium* and *B. lanceolatum*, and even varieties of *B. ternatum*. In Maine, however, it appears to affect the mounds of humus in cedar swamps, farther from water.

As found in Madison, Maine, on July 2d last, it appeared to be more at home than farther south, as the plants were better developed and characteristic in appearance. It was also found to become

bulbous at the base and sheathed by the old remnants of stems as in *B. simplex*, which it also resembles in its general aspect and the size and markings of the spores, differing principally in having a simple lunate-segmented sterile lamina contiguous to the fertile, or at least above the middle of the stipe. The vernation is essentially that of *B. simplex*, both portions being erect, the very tip of the sterile flexed over the top of the fertile, but not bent down (Fig. 6). In a former paper [1] I have given its distinctive characters and shown it to be not *B. simplex* and later [2] I gave a detailed description. Mr. G. E. Davenport doubts the specific rank of this plant, regarding it as a depauperate *B. matricariaefolium*.[3] Both Prof. Underwood and I [4] replied to his criticisms, but it appears well in this place to give some of the chief points of difference between the species. In the accompanying plate Figures 1, 3, 4, and 5 represent pressed specimens of *B. tenebrosum*, natural size; while Fig. 2 shows a depauperate, but fruiting, specimen of *B. matricariaefolium*.

In vernation the buds of *B. matricariaefolium* are stout, the fertile lamina declined at the tip, resting on the top of the sterile of the succeeding year, the sterile of the year embracing the whole with its tip distinctly declined and enveloping the top of the fertile. In *B. tenebrosum*, on the other hand, the buds are much smaller even in plants of the same size, they usually bear a bulbous thickening of dead stalk-bases, and both segments are erect (Fig. 6), as in *B. simplex*. In habit *B. matricariaefolium* is relatively stout, erect, usually bluish as if pruinose, and has no remains of old stalks at the base; *B. tenebrosum* is slender and weak, shining, yellowish, and bears two or three years' accumulation of dead stalks. The aspect of the two is strikingly different when they are growing together.

The sterile lamina of *B. matricariaefolium* is more or less compound, the ultimate lobes being acute. Very rarely, indeed, a plant may be found, in which there are rounded lobes; the apex, however, is always acute (Fig. 10). In *B. tenebrosum* the sterile frond is essentially that of a very lax *B. lunaria*, although thinner and with the apex emarginate. In both species sporangia are borne on the sterile laminae, but in *B. matricariaefolium* they are usually on a transformed compound lobe, making a miniature spike, while in *B.*

[1] Papers Boston Meeting of Fern Chapter, 25.
[2] Fern Bulletin, VII. 7.
[3] Fern Bulletin, X. 22.
[4] l. c. X. 54.

tenebrosum they are always on the margin of the otherwise unaltered segment (Fig. 5). The differences in the sterile fronds are very noticeable even in the earliest stages of the plant.

The fertile lamina of *B. matricariaefolium* is decompound in full grown plants, the rachises are terete, the sporangia sessile or stalked, while in *B. tenebrosum* the spike is usually simple, rarely once pinnate, the rachises are broad, the sporangia sessile in rows or groups on each side, apparently buried in the tissues in life (Fig. 3, 4).[1]

The spores of *B. matricariaefolium* are 308–396 μ, averaging 352 μ, covered with coarse tubercles or warts; those of *B. tenebrosum* are 396–528 μ, average 484 μ, and are finely verrucose. I have previously[2] shown that the bud is elevated each year sufficiently to counterbalance the aggregation of leaves. The older portion of what may be considered as the rootstock persists for several years, and I found several plants in Maine, in which new plants were forming adventitiously from the oldest remaining nodes.

Ames Botanical Laboratory, North Easton, Massachusetts.

Explanation of Plate 48. Figs. 1, 3, 4, 5 are of dried specimens of *Botrychium tenebrosum*, A. A. Eaton, natural size; Fig. 2 is of an herbarium specimen of *B. matricariaefolium*, natural size. Specimens 1, 3, 5 were collected in Skowhegan, Maine; specimen 4 in Brocton, Massachusetts. Nos. 1, 3, 5 have the sterile segment spread out in pressing; no. 4 shows it conduplicate in characteristic manner. At a, Fig. 3, an adventive shoot, springing from a root, is seen. Fig. 6 shows the bud of *B. tenebrosum*, magnified; Fig. 7, that of *B. matricariaefolium*, less magnified. Figs. 8, 9 show the apices of sterile fronds of *B. tenebrosum*; Fig. 10, that of the *B. matricariaefolium* figured above. Figs. 6–10 were drawn with the camera lucida. The others were traced from specimens.

Gaylussacia dumosa and frondosa in New Hampshire: — A Correction.— Owing to a curious and quite unaccountable mixture of labels and specimens a misstatement was made by me in Rhodora, III, 1901, 193–194 under *Gaylussacia dumosa*. The specimen sent me by Mr. Alvah A. Eaton was collected by him at Muddy Pond, Nottingham, New Hampshire on September 15, 1899. Mr. Eaton collected *Gaylussacia frondosa* at French's Pond, North Hampton, New Hampshire (the station I gave for *G. dumosa*) on June 20,

[1] Since writing the above I have seen Prof. Underwood's fine series of specimens, one of which is somewhat ternate and similar to *B. simplex*, var. *subcompositum*.

[2] Papers Boston Meeting of Fern Chapter, 26.

1896 and has since sent me specimens. This makes a second authentic station for that species for the State, as I have already recorded it in RHODORA, I, 1899, 93, from a specimen sent me by Mr. W. S. Harris who collected it on the shore of Cobbett's Pond, Windham, on July 23, 1895. The label reads "Scarce. A tall slender bush, with slender clusters of berries." — WALTER DEANE.

THREE NEW VARIETIES OF ISOETES.

A. A. EATON.

IT has been frequently remarked that although the *genus* Isoetes is world-wide in distribution, the *species* are apt to be very circumscribed in range, often confined to a very small area. As new collections are made, however, it is found that old species are often extended in range as might be expected; but it has also been found that species at first considered to be distinct are only conditions in a series, and plants from new localities often fill the gaps. One remarkable instance is in the case of *I. riparia* and *I. saccharata*,[1] whose characters are found in such a series that the question arises if the latter is really more than a variety of the former.

In some instances the plants of a drainage area may be considered as incipient endemic species, evidently from the same original source as those of other water-courses, but presenting constant or slightly varying differences, apparently caused by geologic conditions in some instances.

The vicinity of North Easton, Massachusetts, exhibits a marked instance of this. The soil is mostly a fine gravel, and no clay has been found. During the past season I have found an abundance of Isoetes, but only three familiar ones, namely, *I. Tuckermani*, and *I. echinospora*, vars. *robusta* and *muricata*. Late in 1902 Mr. R. M. Grey found a small species abundant in the ponds of this vicinity and my search has revealed two others, all of which, although showing some distinctive characters, are best regarded as varieties. The first to be treated is a variety of the very variable *I. saccharata* Engelm. and may appropriately be named for the botanist near whose home it is abundant.

[1] Bot. Gaz. 36: 187–202.

I. SACCHARATA, var. **Amesii**. Trunk 2- 3- 4- or 5-lobed, 4–10 mm. long, 2–5 mm. wide and high; roots very fine: leaves 8–30 cm. long, 1 1.5 mm. in diameter, slender, finely pointed, green and erect when gregarious, spreading when scattered, very narrowly winged to the surface of the soil, quadrangular, the frontal edges elevated, the back flattened; stomata few, bast-bundles none: velum $\frac{1}{3}$–$\frac{2}{3}$ indusiate; sporangia 4 mm. long and 3 mm. wide, white or with a few scattered dark brown cells, very turgid from abundance of spores: gynospores 420–600 μ, averaging 510 μ long, rather sparsely covered with low, fine, rough granules and thin, short, low walls, often reticulated; androspores 28–32 μ long, very finely granulated.

Very common in shallow streams and ponds about Easton, Massachusetts, in fine gravel with or without silt, often forming a dense border a few feet to a rod wide, just at the lowest stage of the water, soon disappearing if exposed to the air. It is peculiar in the various lobing of the trunk. Two handfuls obtained by scraping the soil just deep enough to include the plants and then washing out, were found to have an aggregate of 204 individuals, of which 95 were 2-lobed, 94 were 3-lobed, eleven 4-lobed, and four 5-lobed, a much larger percentage of other than two-lobed trunks than has been found before in the United States except in the three 3-lobed species of the Pacific coast. The only other species that shows a considerable tendency toward a plurilobate form is *I. Tuckermani*, which in some places has 20% with three or more lobes but it is not constant in this trait. Most species may have an occasional plant with a 3-lobed trunk, but our other local ones rarely show a half of one percent so developed. The variety here described differs from *I. saccharata* in its very fine leaves, with few stomata and heterolobing of its trunk.

I have seen what is apparently the same thing from the following localities: Lantern Hill Pond, North Stonington, Connecticut, *C. H. Bissell*, Head of Hambury Cove, Lyme, Connecticut, *Dr. C. B. Graves*, Peeksville, New York, *W. H. Leggett*.

Isoetes riparia has been thought to have a place in the New England flora, but after a thorough study of Dr. Engelmann's material I became convinced that it was not found here, or at least that all previous reports were erroneous. I have recently[1] dealt with most of the material so referred, but several collections made about Uxbridge, Massachusetts, between 1831 and 1864 by Robbins, were

[1] Bull. Torr. Bot. Club. **30**: 359.

of a different appearance and conclusions regarding them were held back until further investigation.

During the past summer I have been so fortunate as to find an abundance of this form at Watson's Pond in Taunton, in Mulberry Meadow Brook in Easton, and Winneconnet Pond, Norton. Its characters are the same in all respects as in Robbins' plants. Although offering several important differences it is quite closely related to *I. Canadensis* (Engelm.) A. Br. and would best be considered a variety of that species. In recognition of the fact that its first recorded collection in America was by one of the best New England collectors of his day I propose to name it

I. Canadensis, var. **Robbinsii**. Trunk bilobed, 8–15 mm. long: leaves, 15–30, 10–38 cm. long, 1–1.5 mm. wide, dark green, very rigidly erect both in water and out, fine-pointed, with stomata and 4 bast-bundles: velum $\frac{1}{5}$ to $\frac{1}{3}$ or more indusiate: sporangia covered with brown sclerenchyma cells; gynospores 450–600 μ, very thickly beset with anastomosing jagged walls (much as in *I. riparia*): androspores 28.7–32.8 μ in long diameter, rough or slightly papillose or with a few tubercles.

This variety differs from *I. Canadensis* principally in its rigid habit, broader velum, densely sclerenchymatous sporangia, and the dense sculpture of the spores, which strongly resemble those of *I. riparia*.

Uxbridge, Massachusetts, "in rather sandy still part of a small stream, leaves ten, 10 inches high, very finely and sharply pointed" *Robbins*, 1831; Millpond, Uxbridge, 1845 and 1864, *Robbins*; Easton, Mulberry Meadow River, Aug. 16, 1903, *A. A. Eaton*; Norton, Winneconnet Pond, *A. A. E.*; Taunton, Watson's Pond, *A. A. E., type.* Robbins' specimens were evidently a source of much uncertainty to Dr. Engelmann. One was annotated as follows: "*Tuckermanni*? *riparia*? *Braunii*? apparently *lacustris*, *I. riparia*?" Another is annotated "*riparia major*" and "*lacustris maxima*." They were all finally included in *I. riparia*.

The aspect of this plant is very much like that of *I. Engelmanni*, especially when growing out of water. When submersed the leaves are rigidly erect and look much like those of some junci. The bulb and leaf bases so far as covered by the mud are apt to be pinkish or cream colored. The variety approximates the terrestrial habit fully as much as *I. Engelmanni*, being found on the border of shallow brooks and near the upper limit of water in ponds.

Associated with both of these at their various stations, but occupying an intermediate zone on the shore, *i. e.* lower down than the latter, but higher up than the former, is a large species, often with 80 to 100 reddish leaves from 10 to 15 inches long, with the appearance of *I. Gravesii*, A. A. Eaton or *I. Eatoni*, Dodge, the sporangia being darker than in those, but very flaccid owing to the comparatively few spores they bear. A careful study has convinced me however, that its affinities are really with *I. foveolata*, A. A. Eaton, from which it differs principally in the spores. In that species they have a generally immature appearance, and occasionally there is a spore that is covered with open, thin-walled reticulations. In this, all the spores are well formed and irregularly honeycomb-reticulated, similarly to those of *I. riparia*. This may be known as

I. FOVEOLATA, var. **plenospora**. Trunks bilobed, 1–2 cm. in long diameter, half as wide and one fourth as high; the bulb of sporanges 1–4 cm. in diameter: leaves 30–110, submersed, reddish or olive green, 1.5 mm. in diameter or more, 20–40 cm. long, fleshy, spreading, somewhat flexuous, the emersed light green, erect tortuous or straight, finely pointed, 1 mm. diameter, all with stomata but no bast-bundles: velum $\frac{1}{4}$-$\frac{1}{2}$ indusiate, sporangia very thickly covered with rather dark brown cells, the color showing through the very thin "area" on the back of the leaf-base: gynospores rather few to each sporangium, usually somewhat glaucous, 450–600 μ, average 510 μ in diameter, covered with irregular, tall, thin, rough, mostly honeycomb-reticulated walls: androsporangia scarce in early season, plentiful in September, the spores 27–33 μ in diameter, very finely granular or with occasional tubercles.

In aspect this variety appears like an overgrown *I. Tuckermanii*, the habit and color being similar. By spore-characters alone it could not be easily separated from the last, nor indeed from several of our reticulate spored species. The reddish color of the leaves appears always to be present, becoming brownish in dried plants. It is more pronounced in the inner leaves, fading as they grow older. Ames Pond, North Easton, Winneconnet Pond, Norton, and Watson's Pond, Taunton, *A. A. Eaton*, scattered rather thinly in silt-covered gravel or in mud where emersed for part of the summer. *Types* from these localities collected by *A. A. Eaton*, 1903.

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Blanche Ames del

SPIRANTHES.

R. G. Leavitt del.

BOTRYCHIUM TENEBROSUM AND B. MATRICARIAEFOLIUM.

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